Pneumatic Transport, Triboelectric Processing of Combustion Fly Ash

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SUMMARY

For many utilities, reducing the amount of carbon in fly ash is important to its application in an economically and environmentally superior manner as a cement admixture. Technologies available to accomplish carbon reduction are limited and costly. Recently, the Center for Applied Energy Research (CAER), in cooperation with industry and EPRI, has performed extensive R&D to establish pneumatic transport, triboelectric separation technology as a viable option for removing carbon from combustion fly ash. This paper discusses the status of this work and describes plans to move the technology into the commercial arena.

Early on, fundamental examinations defined characteristics of carbon and ash that promote tribocharging and separation. The processing conditions necessary for applying pneumatics under fast transport conditions, rather than mechanical or free-fall conditions, were meticulously examined using an analytical separator having a feed rate of 0.5 kg/hr. This work defined the influence of: (1) particle charge magnitude and bipolarity; (2) gas velocities and composition; (3) ambient conditions and the environment, especially the relative humidity and temperature; (4) geometry of the injector, electric field and extractor sections of the system; (5) electric field strength relative to gas velocities; and (6) and ash properties, including particle size and size distribution, and LOI content.

A 25 kg/hr feed rate separator was also constructed and operated. The R&D on its operation and performance further refined gas transport, triboelectric separation processing. A new idea related to gas membrane purification processing grew out of this work. In this new concept, the separation of a fine powder, physical mixture like carbon in coal combustion ash occurs under a container-less, gas membrane environment. This way of defining the conditions of processing suggests that contamination of the material to be processed can be minimized or eliminated. Our

experimentation has shown this condition can be met.

Subsequently, a proof-of-concept (POC) triboelectric separation platform was designed and constructed, and is operated at the CAER. It has a 250 kg/hr feed rate capacity and has a throughput rating of approximately 21 ton/m^2/hr. Operationally and in design, it reflects the 25 kg/hr feed rate system. The POC platform is also capable of operation in a recycle mode, wherein a portion of a product or products can be recycled back to the electric field cell to effect increased purification.

Using data from the 25 kg/hr system, EPRI performed a preliminary economic assessment of the technology. A conceptual design was created for a commercial carbon-ash separation plant that could process fly ash at a 10.2 ton/hr feed rate capacity. This system was large enough for a 250 MW coal-fired power plant. Some of the key findings from this study were that: the yield of the low-LOI product needed to be equal to or greater than 42% for the process to be economically successful if disposal costs were approximately $10/ton; the yield of the low-LOI product needed to be greater than only 15% for the process to be economically successful if disposal costs were approximately $30/ton; and, the installation of the process reduced the levelized cost of electricity by 0.16 mil/kWh if disposal rates were reduced by 60%.

The next step in developing pneumatic transport, triboelectric separation technology for utility applications is beyond that which can be accomplished in a laboratory or university setting. It is believed that a reasonable next step would be a 2-5 ton/hr demonstration system located within a utility. The design of this larger system is possible because of the knowledge gained and performance data obtained during our scale-up to and operation at a feed rate of 250 kg/hr. Hence, we aim to demonstrate the technology at a utility-relevant scale and are formulating plans to do so in the near term.